**Lesson Topic:** Symmetry and Transformation – Create Designs using Symmetry (Frieze patterns)

**Concept/s in Focus:**
- A transformation that leaves a shape unchanged but its orientation or location changed is called a rigid transformation.
- An object that remains unchanged after a transformation has symmetry.
- There are four types of rigid transformations / symmetry - translation, reflection, glide and rotation.
- Translation symmetry occurs when shapes are slid a constant distance.
- Translation symmetry does not require a line of symmetry.
- Reflection symmetry occurs when shapes are reflected across a line of symmetry. The reflected shape is a mirror image of the original shape and will be the same distance from the reflection line.
- Glide symmetry involves a combination of a translation and a reflection.

**Introduction / Teacher Background Information:**
A frieze is a design that is repetitive in one direction. All frieze patterns have translation symmetry as the base image or shape is moved a constant distance in one direction (translated or slid). Frieze patterns can continue in both directions. Creating the shape that is repeatedly translated can be done in many ways that all involve symmetry.

Translation symmetry moves a shape a constant distance in a line. Reflection symmetry flips a shape across a line and the line can be vertical or horizontal.

Glide symmetry involves a translation and reflection.

Translation symmetry is often described as a slide and reflection symmetry as a flip. These descriptions of how the pre-image shapes are moved to become the symmetrical image are comfortable ones for students learning about symmetry.

This lesson investigates 5 different frieze patterns that can be created using just reflection and translation symmetry. There are other frieze designs that also incorporate rotation symmetry but these are being left for another lesson.

**Australian Curriculum links:** ACMMG091

**Resources:**

**Whole Class Activity:**
- A copy of the Frieze Patterns PowerPoint and space to project it
- At least 6 copies of the Shapes for Frieze Patterns A5 copied on coloured paper and cut out. If possible copy these shapes onto coloured paper.
- The Mat

**Hands-On Activity:**
- A copy of Create Designs Using Symmetry activity per student (3 pages)
- Scissors and glue

**Independent Activity:**
- A copy of the Frieze Transformations worksheet per student
- Scissors and glue
Whole Class Activity:
- Have the students gather where they can see the Mat folded to show only 2 rows of 10.
- Choose one of the two A5 shapes in the Shapes for Frieze Patterns A5 file and have copies of that shape ready for use.
- Review the translation (slide) and reflection (flip) transformations to place a second copy of the shape in a symmetrical position.
- Place two copies of the shape chosen in the first space on the top row of the Mat (to the students’ left) – one on top of the other.

I have put two copies of this shape in this space.. one on top of the other. We are going to use these shapes to revise some ideas about symmetry. Who can tell us something about symmetry?

- Ask a few students to share their understandings of symmetry e.g. mirror image, same distance, flip and slide etc. listening for key ideas at this early stage of the lesson.

Can someone come out and show an example of symmetry by moving the top shape into a new position?

- Choose a student to come to the Mat and move the top shape.
- Watch how they move the shape – the possible options are to reflect (flip) the shape, translate (slide) the shape, glide (translation and reflection) or rotate (turn) the shape. The focus in this lesson is only on translations and reflections. Rotations will be the focus of further lessons.

What sort of symmetry have you shown with the two shapes? What did you do to the second shape to create the symmetry?

- Listen to how the student describes the symmetry. Seek demonstrations of the other types of symmetry by asking for further volunteers. If students do not provide the three options (translation, reflection and glide) demonstrate them for the class. Prompt the class to describe the symmetry rather than just telling them e.g.

What sort of symmetry is this? How did the shapes move to create this symmetry?

- Ensure the class is in a space where ideally they can see a screen (or wall) where the PowerPoint will be projected and have access to the Mat on the floor so each of the five different frieze designs shown on the PowerPoint can be modelled.
- Note: The PowerPoint contains animations to step the class through the method used to create each of the five different friezes – Translate only, Reflect over a vertical line, Reflect over a horizontal line, Glide and Reflect over vertical and horizontal lines.
- Introduce the idea of friezes using the images on the first slide.

What do you notice about each of these friezes?

- Listen for description of the pattern and the repetition of shapes. Listen particularly for mention of types of symmetry. The second slide of the PowerPoint gives a definition of a frieze. Wait until after the students have made observations before giving the definition.
- Work through the PowerPoint one example at a time. Pause after the first question is asked on the screen “What happens to this shape to create this frieze” and allow the students to visually analyse the frieze and the base shape before progressing through the slide.
- After each example, return to the Mat and demonstrate the creation of the frieze from the PowerPoint using the paper shapes on the Mat.
- Ensure students understand that the transformation of the original shape creates the base design that is then translated along the frieze.
Hands On Activity:

- The activity in this section of the lesson gives all students a chance to practise translations, reflections and glide transformations for themselves, with the guidance of the teacher, and in a way they can observe their classmates making patterns as well.

- The space for creating designs on the activity sheet is divided into sections to guide the placement of the shapes and to give lines for the reflections to be made across. In this section of the lesson the focus is on the students making the transformations of the shapes – getting the translations, reflections and glides worked out more so than the artistic outcome of their work.

Now it is your turn to make some designs using symmetry. Choose one of the shapes on the page of shapes you have. It can be any of the shapes.

- Lead the students through the set up to choose a shape, cut out 2 of the shapes (to start with) by cutting the actual border of the shape not just roughly around the shape and to colour the back of the shapes or another colour.

- Use the large A5 shapes from the Whole Class section of the lesson to demonstrate the transformations e.g. on the whiteboard. Use 2 of the same shape to model for the class.

- Revise each transformation modelling while the students manipulate the shapes they have.

Start with the two shapes you have cut out and put them on top of each other. The first symmetry we will try is a translation. Who can tell us how to move the top shape to show a translation? What is the other name for a translation? (slide).

- Model the translation by placing 2 shapes on top of each other on the whiteboard (they will need removable adhesive to keep them in place) and sliding the top shape to show the translation to a new position.

- Help the students to do the same with the shape they chose on their desk.

- Model a reflection across a vertical line. Place two identical shapes on top of each other on the whiteboard and draw a vertical line.

The next symmetry we will try is a reflection – across a vertical line. Who can tell is how to move the top shapes to show a reflection across a vertical line like I have on the board? What is the other name for a reflection? (flip).

- Help the students to complete the reflection across a vertical line.

- Model a reflection across a horizontal line, then a glide (reflection and translation).

- Provide each student with a copy of the Create Designs Using Symmetry activity (2 pages – the activity page and the page of shapes. When copied one side of the shapes in the activity will be black on one side. By shading the reverse the shapes will work better for the transformation when cut out around the border of each shape.

- Move around the classroom assisting the students to complete the transformations listed at each stage of the design. Ensure the students start with two shapes on top of each other so the original shape orientation is maintained and the transformation is visible compared to the original. As they add a new shape it needs to be placed over the previous one, then moved.

- Watch how the students transform the shapes using translations, reflections and glides. Use these terms as well as flip and slide as the students work to increase their familiarity with the terms.
• Share the different designs created by different students made using different shapes and different transformations.

**Independent Activity:**

• Provide each student with a copy of the Frieze Transformations worksheet per student.
• This worksheet follows the same format as the PowerPoint in the Whole Class section of the lesson and uses the transformations practised in the Hands On section of the lesson to make the five different friezes that use translation and reflection symmetry.
• Ensure the students know to colour the back of the shapes for more consistent friezes.
• Students can choose any shape for any of the friezes. Some of the shapes are the same as those used in the Hands On section of the lesson.
• Move around the classroom as the students work observing how they perform the transformations and offering assistance as needed.

**Understandings to look for:**

• Students who can perform translations and reflections to create symmetrical designs.
• Students who can complete a glide translation (combination of translation and reflection)
• Students who can recognise shapes that are symmetrical after a translation.